REMARKS

Claims 1 through 15, 17, 18, 20, 22 through 26 and 28 through 31 are in the application and are presented for consideration. By this amendment, new claims 28 through 31 have been added. Claims 16, 19, 21 and 27 have been canceled. The application presents the same number of claims as previously presented. As two new independent claims are presented, providing a total of four independent claims, the fee for one additional independent claim is being submitted.

New claims 28 and 29 depend on claims 4 and 11 respectively, and highlight the features that the laser power is controlled as function of said displacing motion and said deflection motion and of said angle of incidence of the laser beam on the workpiece. New independent claims 30 and 31 include similar features.

The specification has been objected to. Applicant has made changes to the specification which address the issues which have been raised.

Claims 1 through 27 have been rejected under 35 U.S.C. 112, second paragraph as being indefinite. Applicant has now revised each of the claims paying close attention to the comments made in the Office Action. Applicant wishes to thank the Examiner for the careful reading the claims and for the helpful comments. It is Applicant's position that the claims as now presented are clear and definite and fully conform with the requirements of the statute.

With regard to the terms workpiece and workpieces, Applicant is using the term workpiece to relate to one or more objects or parts on which machining is performed. This may be for example one or more parts or portions already connected or parts or portions not

yet connected that form a unit being worked on. The workpiece can be two distinct parts which are together worked on such as with a joining operation that includes laser welding. Sometimes the parts are already loosely connected or clamped. In either case, loosely connected parts clamped parts and multiple distinct not already connected parts, they are still referred to as a workpiece, namely what is being worked on.

Claims 1,4, 5, 8, 10, 13, 14, 18, 20-22, 26, and 27 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Akeel (US Re.34597) in view of Iehisa (US 6,555,784).

The invention is based on implementing a laser machining process in which a multiaxial manipulator moves a multiaxial manipulator hand (robot hand) with a displacing motion along a machining path. The moved robot hand carries a laser tool and moves the laser tool relative to a workpiece. In the past, machining operations have been performed with such displacing motion with the hand moved such that the laser beam essentially is directed to form about a 90° angle with the surface of the workpiece. The invention is based on a new technique in which in addition to the movement of the robot hand relative to the workpiece surface, the laser (the laser tool) is also deflected by means of the motion of the hand to vary a deflection angle α to move the laser beam about one of the various axes of the robot hand. This allows for significant efficiencies with regard to welding in that the speed of welding is not limited to the movement of the robot hand relative to the surface. In addition to that movement, the movement of the laser beam about the hand axes allows the laser beam itself to move more quickly and more efficiently on the workpiece surface. This is accomplished by deflecting the laser beam by variable deflection angles resulting in varying the angle of

incidence β of the laser beam on the workpiece surface. The invention varies the power of the laser beam output by the tool based on the movement of the laser relative to the workpiece. In this way, variations in speed of movement of the laser as well as variations in angle of incidence of the laser do not affect the laser weld or laser cut at the workpiece surface. The lower laser power that would otherwise be applied to the surface of the workpiece, based on a speeding up of the laser beam or based on an angle of incidence which deviates from 90°, is offset by increased power of the laser beam itself. In a similar manner, a slowing of the laser beam and applying the laser beam closer to 90° relative to the surface of the workpiece requires a lower laser beam power. The invention is able to provide significant efficiencies with regard to laser machining based on the concept of superimposing the deflection motion of the laser beam on the displacement motion of the robot hand. The invention avoids problems with regard to fluctuations in the power applied to the surface of the workpiece that accompany variations in speed of the laser and variations in the angle of the laser beam relative to the surface of the workpiece.

It is Applicant's understanding that the prior art does not teach or contemplate deflection of the laser beam by motion of the hand about one or more hand axis. Indeed, it is Applicant's understanding that the prior art uses manipulators to move a laser beam such that it forms about a 90° angle relative to the workpiece surface with the manipulator movement of the hand. With the laser beam directed in such a manner, the speed at which machining is provided is limited to the movement of the robot hand relative to the workpiece surface.

Akeel teaches a robot laser system to provide a laser source and coupled movable

channels with mirrors for conveying laser light (conveying the laser beam) to an outlet location for machining. With Akeel there is internal guiding of the laser light and no laser tool at the end of a manipulator hand. It is noted that Akeel does not teach or suggest that the disclosed embodiment has a power source in which laser power can be controlled. Indeed, the reference at column 1, line 44 to "regulating the laser power" is with reference to the prior art (background art). As such, the rejection appears to be based on a further combination, namely Akeel in view of the discussion of a prior art laser power regulating device and further in view of the stated secondary reference Ichisa et al. In any event, as with the rest of the prior art, Akeel does not teach and does not suggest a welding device or process in which the laser beam is deflected in combination with movement of the robot hand holding the laser tool. The prior art as a whole fails to teach the basic combination which presents the problem which applicant is addressing. The references do not recognize the source of the problem as they do not encounter it, they do not provide a varying deflection angle and most importantly do not have the laser beam angle of incidence at the workpiece surface which varies. To the extent that Akeel mentions that the prior art regulates a laser's power, there is no teaching or suggestion of varying a deflection angle or varying a laser beam incidence angle at the workpiece and there is no teaching or suggestion of varying power based on movement of the laser beam at the workpiece surface. As these concepts are missing from the primary reference, the rejection is untenable.

Ichisa et al. teaches a laser machining apparatus which has a plurality of laser generators with generate laser beams that are combined and passed along a fiber-optic cable.

The cable has various different splitters (OP1, OP2, OP3...) that split off a portion of the guided laser beam. In this way, a laser tool (TL1, TL2, TL3...) at any of the particular robots (RB 1, RB 2, RB 3...) can be selectively supplied with a laser beam so as to selectively feed laser tools which are to be operational and to not send the laser beam to tools which are not operational. The teaching of these features does not provide any teaching or suggestion which leads to Applicant's invention, either taken alone or taken in combination with the teachings of Akeel and the mentioned Akeel background art. According to the Ichisa et al. teachings there is no suggestion of varying power of the laser beam which is emitted by any one of the tools. The tool is either supplied with a laser beam or is not supplied with a laser beam. There is no power controlled at the emitter or laser tool. The splitters (OP1, OP2, OP3...) determine whether the laser beam reaches the associated tool or not and does not vary the power of the laser beam which is applied by the tool.

According to Ichisa et al., energy is supplied which is enough to weld. The system controls the whole laser output but does not control the individual power output at a laser tool. Further, with the teachings of each of the references, no control of power output is possible which is dependent on an angle of the laser beam. The references do not teach these features and do not appear to provide the possibility of such power control.

As noted above, normally with laser machining, such as laser welding, a laser beam is applied on the surface of the workpiece and this is typically at about a 90° angle relative to the workpiece surface. With the invention, short quick movements are possible resulting in the laser beam hitting the workpiece at an angle including angles which are other than 90° (see

Figures 7 through 12). In this case, the power of the laser that acts on the surface of the workpiece depends on the beam movement including the incident angle. The invention controls the laser power at the tool based on the movement of the laser beam relative to the surface of the workpiece (as a function of overall laser movement including the angle of incidence). This allows an even and uniform machining and also allows for significant efficiency and speed improvements as compared to the prior art, as noted above.

With the invention the control has construction details of the workpiece, namely information regarding the surface of the workpiece, spot on the workpiece where machining is occurring, and the control knows the deflection angle and other aspects of the movement of the laser. The power of the laser beam applied by the tool is varied as needed. With the laser beam at about 90° relative to the workpiece surface, almost 100% of the power is applied to the workpiece. When the angle approaches 45°, much more power is required to achieve the same machining result. The invention provides significant efficiency and speed advantages based on the deflection of the laser beam resulting in the quickest possible machining. This differs significantly from prior art methods in which the laser beam is applied at about 90° relative to the surface. The prior art machining takes much more time and does not encounter the problem which is addressed according to the invention.

The rejection does not present a prima facie case of obviousness. The references do not together teach each of the features as claimed. The combination of teachings do not provide the claimed combination. Further, the references fail to suggest the combination as claimed. Accordingly, it is requested that the rejection be reconsidered. Further, it is requested

that the new claims be favorably considered.

Claims 7, 16, and 17 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Aheel in view of Iehisa and Ishiguro (US 4831316).

As noted above, the prior art fails to suggest the features of the independent claims and intervening claims. Further, the teachings of an input unit do not suggest the combination of process features wherein the input of data is closely linked to the other features of the invention. An input of data or features to input data for different purposes does not suggest the input data to provide both the movement of the robot hand as well as the deflection of the laser beam with a varying angle feature as discussed above. The references do not suggest the basic crux of the invention and do not suggest features which can attain the advantages of the process and apparatus as claimed. Accordingly, it is requested that the rejection of claim seven, 16 and 17 be reconsidered.

Claims 2, 3, 11 and 12 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Aheel in view of Iehisa and Briand (US 6603092 B2).

It is Applicant's position that the additional reference Briand fails to teach and fails to suggest the feature for which it is cited, namely providing a laser beam deflection motion as claimed. Instead, it appears that Briand discloses applying the laser beam on the workpiece surface at about a 90° angle (Figure 5). The cited text makes reference to movable deflection mirrors which are moved to either allow the laser beam to be applied to the work surface or which deflect laser beam to a well which absorbs the laser beam energy. This is basically an on-off switch. There is no teaching and no suggestion of varying a deflection angle as claimed.

Accordingly, Applicant respectfully requests that the rejection be reconsidered. The prior art as a whole fails to teach and fails to suggest the combination of features claimed.

Claims 6 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Aheel in view of Iehisa, Briand, and Hamada (US 6888096 B1).

With the invention, the movement of the laser beam, including displacing and beam deflecting motions can be used for varying the energy applied for machining. This is neither taught or suggested by the prior art. Hamada teaches a homogenization and linearization of laser light. This does not use the movement of the laser beam including the angle of the laser beam (the incident angle laser on the workpiece surface) for the purpose of applying energy based on the predetermined section energy to be introduced. The prior art including Hamada is directed to different techniques, which for the most part apply laser energy at an angle of about 90° relative to the workpiece surface. These references do not suggest the novel and very different approach of the invention and do not have a need for features as claimed. Accordingly, reconsideration of this rejection is requested.

Claim 19 has been rejected under 35 U.S.C. 103(a) as being unpatentable over Aheel in view of Iehisa and Shah (US 6486436 B1).

Although clamping and other tool arrangements may be known generally for use during welding and other machining operations, the prior art as a whole fails to suggest the novel and different approach which the invention takes. The references do not suggest the features of the independent and intervening claims. Further, there is no suggestion of providing an arrangement or process as claimed with clamping other tools as claimed. Accordingly, the

subject matter should be considered patentable. Applicant respectfully requests that the rejection be reconsidered.

Claims 9, 23, and 24 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Aheel in view of Iehisa and Ortiz, Jr. (US 5245682).

The features leading to the focal distance are important given the need to position the laser tool relative to the work surface as well as the deflection of the laser beam resulting in minor but potentially important changes in this distance (Figure 5 with a distance *df*). Although changing the focal distance or providing a particular lens with a particular focal distance may itself be known, there is no suggestion in the prior art to combine this with the other features claimed. Most notably, with the invention there is a positioning of the welding head (and the welding tool with a distance relative to the work surface as well as a movement of this in a travel direction as well as a deflection of the laser beam. The prior art does not contemplate this and does not contemplate the various issues relating to focal length which are related to the claimed features. Accordingly, the combination of features should be considered patentable. It is requested that the rejection be reconsidered.

Claim 25 has been rejected under 35 U.S.C. 103(a) as being unpatentable over Aheel in view of Iehisa and Maruyama et al (US 6100497).

Although the prior art may generally teach the concept of a common laser source switched to various different laser tools, there is no teaching with this in combination with the other features claimed including varying the power of the laser beam applied by the tool. These aspects of the invention are important and the prior art fails to direct the person of

ordinary skill in the art toward the claimed combination. Accordingly, is requested that the rejection be reconsidered.

The prior art as a whole fails to teach and fails to suggest the combination of features claimed. The prior art directs the person of ordinary skill the art toward different laser machining techniques wherein these do not encounter the issues which are encountered according to the novel and different technique practiced according to the invention. The prior art fails to teach concepts including displacing the manipulator head along a machining path with the manipulator head carrying a laser tool spaced from the workpiece and with the laser beam deflected with variable deflection angles with the power of the laser varied as a function of the motion of the laser beam relative to the workpiece surface. The invention presents an important departure from the prior art and presents significant advantages compared to prior art teachings. The combination of features is not suggested by the prior art as a whole. Accordingly, it is requested that the rejections be reconsidered and that the application be allowed.

Further and favorable action on the merits is requested.

Respectfully submitted
for Applicant,

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SHOULD ANY OTHER FEE BE REQUIRED, THE PATENT AND TRADEMARK OFFICE IS HEREBY REQUESTED TO CHARGE SUCH FEE TO OUR DEPOSIT ACCOUNT 13-0410.

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